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Maxomystrongylus yasumai gen. and sp. n. (Nematoda: Trichostrongylina: Heligmonellidae) Collected from Murid Rodents in Kalimantan, Indonesia

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ABSTRACT: *Maxomystrongylus yasumai* gen. and sp. n. (Nematoda: Trichostrongylina: Heligmonellidae: Nippostrongylinae) is described based on the specimens collected from the small intestine of *Maxomys whiteheadi* (Rodentia: Muridae) from East Kalimantan, Indonesia. This parasite was also found from *Rattus rattus diardii* and *Niviventer cremoniventer* (Muridae) in the same locality. *Maxomystrongylus* is closely allied to *Heligmonoides* but is distinguished by having a more strongly inclined axis of orientation of ridges in midbody, developed slender ridges lacking basal thickening in left lateral side of body, and a large unilateral diverticulum of the vagina vera. *Maxomystrongylus yasumai* is distinguished from *Maxomystrongylus musseri* (Hasegawa and Syafruddin, 1994) comb. n. (syn. *Heligmonoides musseri*) from *Maxomys musschenbroekii* of Sulawesi by having a smaller body, more closely set left lateral developed ridges, unequal dorsoventral height in the lateral lobes of the bursa copulatrix, a dorsal ray being divided distal to its midlength and shorter spicules in the male, and absence of a carene at the level of the ovejector and a more pointed tail in female. *Maxomys* murines seem to be the primary hosts of *Maxomystrongylus* in both Kalimantan and Sulawesi.

KEY WORDS: *Maxomystrongylus yasumai* gen. and sp. n., *Maxomystrongylus musseri* comb. n., Nematoda, Trichostrongylina, Heligmosomoidea, Heligmonellidae, Muridae, Kalimantan, Indonesia.

Heligmonoides musseri Hasegawa and Syafruddin, 1994 (Trichostrongylina: Heligmosomoidea: Heligmonellidae: Nippostrongylinae), described from the endemic murines of Sulawesi, Indonesia, was tentatively classified in the genus *Heligmonoides* Baylis, 1928, because the left lateral 4 ridges in the midbody are well developed (Hasegawa and Syafruddin, 1994). This species, however, is quite specialized in that the developed left lateral ridges are slender and winding, and the vagina vera has a unilateral prominent diverticulum, suggesting that it belongs to an undescribed genus (Hasegawa and Syafruddin, 1994). During a medicozoological survey carried out in East Kalimantan, Indonesia, in 1993, a new nematode species sharing many common characteristics with *H. musseri* was collected. This paper proposes a new genus for these 2 species.

Materials and Methods

Rodents were captured in the Bukit Soeharto Preserved Forest near Samarinda, East Kalimantan, Indonesia, using wire-cage live traps and plastic snap traps baited with baked coconuts. Their viscera were fixed in 70% ethanol and transported to the laboratory and refixed with 5% formalin solution. Then the alimentary canals were cut open and washed with running water on a mesh with a pore size of 0.075 mm in diameter, and the residues on the mesh were transferred to a petri dish and examined carefully under a stereomicroscope. Detected nematodes were rinsed in 70% ethanol, cleared in glycerol by evaporation of a glycerol–alcohol solution, and then mounted with 50% glycerol for microscopical examination. Freehand cross-sections were made for observation of the synlophe and cephalic structures (Durette-Desset, 1985). Figures were made with the aid of a drawing tube. Measurements, in micrometers unless otherwise stated, are given for the holotype male and the allotype female, followed in parentheses by the range for paratype males and females from the type host. The classification system follows Durette-Desset and Chabaud (1993). The terminology of the synlophe and bursal rays follows that of Durette-Desset (1983). Specimens are deposited in the Museum Zoologi Bogor (MZB), Bogor, Indonesia, and the United States National Parasite Collection (USNPC), Beltsville, Maryland, U.S.A.

Results

A species of nematode belonging to the subfamily Nippostrongylinae (Trichostrongylina: Heligmosomoidea: Heligmonellidae) was collected from *Maxomys whiteheadi*, *Rattus rattus diardii*, and *Niviventer cremoniventer*. It was common in *M. whiteheadi*, and the intensity of infection was also high in this murine (Table 1).

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Table 1. Prevalence and intensity of *Maxomystrongylus yasumai* sp. n. in murines collected in the Bukit Soeharto Preserved Forest, East Kalimantan, Indonesia, August 1993.

Host species	Prevalence (No. positive/ No. examined)	Mean intensity (range)
Maxomys whiteheadi	14/17	>70 (1–200)
Rattus rattus diardii	1/1	5
Niviventer cremoniventer	1/2	5
Rattus exulans	0/2	—
Leopoldamys sabanus	0/1	—

This nematode was not found in 2 *Rattus exulans* and 1 *Leopoldamys sabanus* captured in the same forest.

The following description is based on the material from *M. whiteheadi*.

Description

Maxomystrongylus gen. n.

DIAGNOSIS: Trichostrongylina: Heligmosomoidea: Heligmonellidae: Nippostrongylinae. Synlophe with pointed ridges. Axis of orientation of ridges passing from ventral right to dorsal left sides with inclination of about 70° from sagittal axis in midbody. Gradient in size of ridges in dorsal side lateromedian. Carene of type B present. Left lateral 3 or 4 ridges developed, slender but not thickened basally. Bursa copulatrix asymmetrical with larger left lobe. Dorsal ray divided distal to level of derivation of ray 8. Genital cone not protruded prominently. Vagina vera with unilateral diverticulum. Parasitic in murines.

GENOTYPE: *Maxomystrongylus yasumai* sp. n.

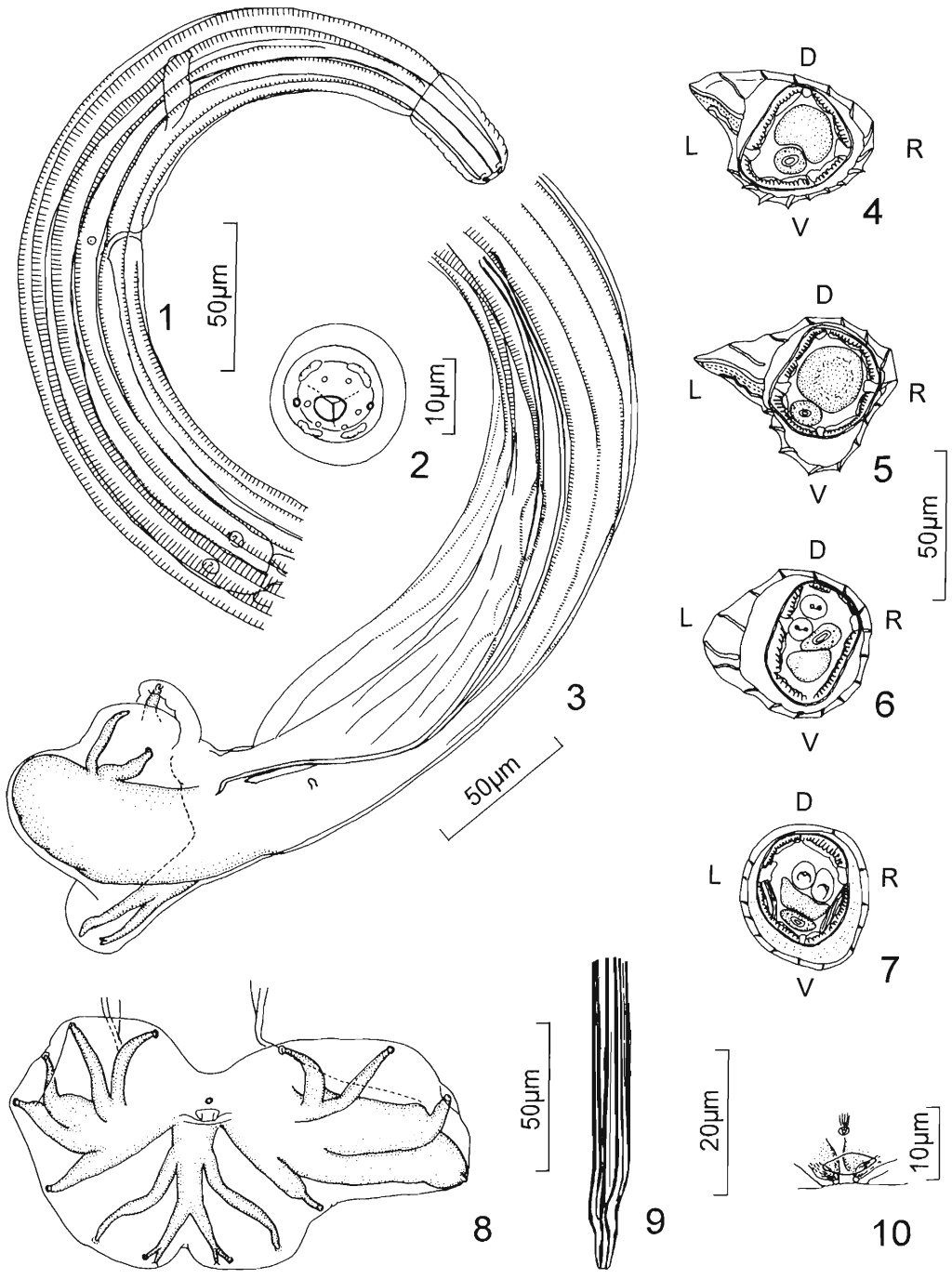
OTHER SPECIES: *Maxomystrongylus musseri* (Hasegawa and Syafruddin, 1994) comb. n. (syn. *Heligmonoides musseri* Hasegawa and Syafruddin, 1994)

ETYMOLOGY: The generic name is made by combining "*Maxomys*," the genus of the type host, and "strongylus," meaning a round worm.

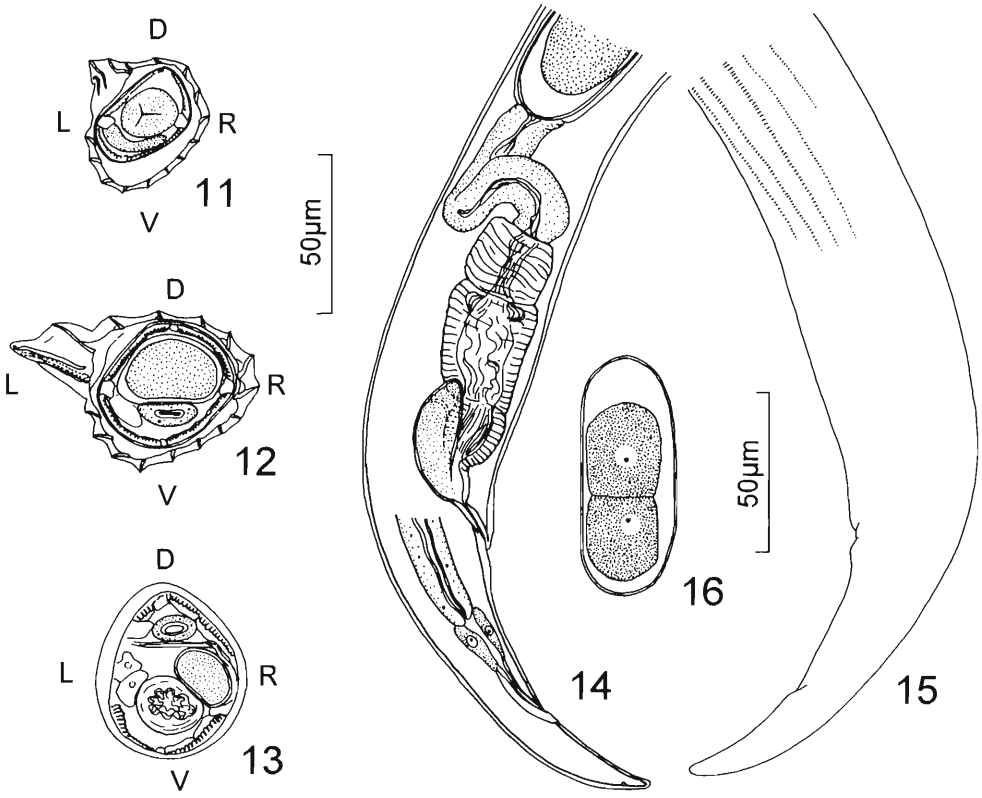
Maxomystrongylus yasumai sp. n. (Figs. 1–16)

GENERAL: With generic characteristics already outlined. Small worm forming sinistral coils about ventral surface. Cephalic vesicle present (Fig. 1). Esophagus club-shaped (Fig. 1). Nerve ring at anterior portion of middle ⅓ of esophagus, and excretory pore and deirids slightly posterior to middle of esophagus (Fig. 1). Mouth triangular, surrounded by 4 cephalic papillae, 6 minute externolabial papillae and amphidial pores (Fig. 2). Cuticle with fine transverse striations. Synlophe ridges commencing posterior to cephalic vesicle (Fig. 1) and ending anterior to level of prebursal papillae in male (Fig. 3) and at level of sphincter in female (Fig. 15). Inclination of synlophe ridges from sagittal axis 30° in esophageal level (Fig. 11), 50° in anterior intestinal level (Fig. 4), and 70° in middle and posterior body (Figs. 5, 6, 12). Ridges becoming minute, lacking clear axis of orientation at level anterior to prebursal papillae of male (Fig. 7). In midbody, 17 or 18 ridges present in both sexes; cuticle of left lateral side markedly dilated forming carene supported by 3 slender ridges of which middle one longest, closely set with ventral undulating ridge, and cuticle between these 2 ridges strongly sclerotized; right lateral ridge and adjacent dorsal ridge well developed; left ventral 3 ridges larger than other ventral ridges (Figs. 5, 12).

MALE (holotype and 10 paratypes): Length 1.89 (1.67–2.03) mm, width at midbody 53 (48–56). Cephalic vesicle 37 (32–37) long by 19 (17–21) wide. Nerve ring 124 (108–151), excretory pore 178 (156–195) and deirids 184 (158–201) from cephalic end. Esophagus 325 (291–353) long by 23 (21–26) wide near posterior end. Bursa asymmetrical: dorsoventral height larger in right lobe and lateral width much larger in left lobe, and dorsal and ventral incisions present (Figs. 3, 8). Ray 1 minute, at level of gubernaculum (Fig. 3). Bursal rays terminating near bursal edge: rays 2 and 3 almost equal in size, widely divergent from base; lateral rays with thick common base, rays 4 and 5 stout, especially in left lobe, running together but divergent distally; ray 6 thinner than rays 4 and 5 and arising from middle of ray 5 in right lobe and from proximal ⅓ of ray 5 in left lobe; dorsal ray divided into 2 widely divergent branches at level distal to midlength, and each branch divided again into 2 unequal offshoots distally; ray 8 arising from basal ⅓ of dorsal ray, almost equal with dorsal ray in length (Fig. 8). Genital cone slightly elevated, with 1 unpaired papilla on anterior lip and 1 pair of papillae on posterior lip (Fig. 10). Spicules equal, alate, distal ends adhered to each other and abruptly bent dorsally, 260 (235–270) long, equivalent to 14% (13–15)



Figures 1–10. Male of *Maxomystrongylus yasumai* gen. and sp. n. from *Maxomys whiteheadi* of East Kalimantan, Indonesia. 1. Anterior part of holotype, right lateral view. 2. Cephalic extremity, apical view. 3. Posterior part of holotype, left lateral view. 4–7. Cross-sections through anterior portion of intestine (4), midbody (5), proximal portion of spicules (6), and midlevel of spicules (7). 8. Bursa copulatrix of a paratype, ventral view. 9. Distal ends of spicules. 10. Genital cone, ventral view. Abbreviations: d-dorsal, l-left, r-right, v-ventral.



Figures 11–16. Female of *Maxomystrongylus yasumai* gen. and sp. n. from *Maxomys whiteheadi* of East Kalimantan, Indonesia. 11–13. Cross-sections through posterior portion of esophagus (11), midbody (12), and vestibule (13). 14. Posterior part of allotype, right lateral view. 15. Cuticle surface of posterior part of allotype, left lateral view. 16. Egg. Abbreviations: d-dorsal, l-left, r-right, v-ventral.

of worm length (Figs. 3, 9). Gubernaculum boat-shaped, 24 (22–28) long (Fig. 3).

FEMALE (allotype and 10 paratypes): Length 2.04 (1.72–2.22) mm, width at midbody 51 (48–58). Cephalic vesicle 35 (29–35) long by 20 (18–22) wide. Nerve ring 121 (103–134), excretory pore 174 (144–186) and deirids 180 (146–190) from cephalic end. Esophagus 319 (299–355) long by 24 (19–26) wide near posterior end. Vulva 104 (93–125) and anus 46 (36–53) from caudal end (Fig. 14). Vagina vera with elongated right side forming horn-shaped diverticulum reaching midlevel of vestibule, and 60 (49–64) long; vestibule 53 (50–69) long, divided into anterior dilated and posterior compact portions; sphincter 21 (16–24) long; infundibulum 91 (84–116) long (Fig. 14). Tail conical with moderately pointed apex (Fig. 14). Eggs ellipsoidal, thin-shelled, containing 1–2-cell-stage embryos, and 64–74 by 26–34 (Fig. 16).

TYPE HOST: *Maxomys whiteheadi* (Muridae: Murinae).

OTHER HOST: *Rattus rattus diardii*, *Niviventer cremoniventer* (Muridae: Murinae).

TYPE LOCALITY: Bukit Soeharto Preserved Forest (0°51′S, 117°2′E, 50 m elevation).

SITE OF INFECTION: Small intestine (duodenum to middle of jejunum).

DATE OF COLLECTION: 21 August 1993.

ETYMOLOGY: The species name is dedicated to Dr. Shigeki Yasuma, the Tropical Forest Research Project, Samarinda, East Kalimantan, Indonesia, to whom we are greatly indebted for his kind help in trapping the rodents.

SPECIMENS DEPOSITED: MZB Na286 (holotype and allotype); MZB Na287 (4 male and 4 female paratypes), and USNPC No. 86763 (6 male and 6 female paratypes), from *M. whiteheadi*. USNPC No. 86764 (2 males and 2 females) from *R. rattus diardii* and USNPC No.

86765 (1 male and 2 females) from *Niviventer cremoniventer*.

REMARKS: *Maxomystrongylus* resembles *Heligmonoides* in that the 3 or 4 left lateral ridges are larger than other ridges supporting a carene of type B (Durette-Desset, 1983). *Maxomystrongylus*, however, differs from *Heligmonoides* because the inclination of axis of orientation of ridges in midbody exceeds the range for other members of Nippostrongylinae (45–67°) (Durette-Desset, 1983). Moreover, the slender left lateral ridges are quite different from the developed left lateral ridges in *Heligmonoides* species that are thickened basally except in *Heligmonoides bulbosus* Ow Yang, Durette-Desset, and Ohbayashi 1983 (Durette-Desset, 1970; Wertheim and Durette-Desset, 1975; Hasegawa and Otsuru, 1982; Ow-Yang et al., 1983; Hasegawa, 1990). Although the vagina vera has not been adequately described or illustrated in some *Heligmonoides* species, its diverticulum is usually extending dorsally, not laterally (cf. Hasegawa, 1990). Thus, the unilateral diverticulum of female *Maxomystrongylus* may also be a key characteristic of the genus.

Maxomystrongylus musseri belongs to this genus because it has all of the generic characteristics described earlier (Hasegawa and Syafruddin, 1994). This species is easily distinguished from *M. yasumai* because it has a larger body (1.78–2.38 mm by 70–86 in male and 2.29–2.94 mm by 64–81 in female), the left lateral slender ridges are widely separated from each other in midbody, the dorsoventral height of the bursa copulatrix is almost equal in both sides, ray 6 in the left lobe is arising from the distal half of ray 5, the dorsal ray is divided proximal to its midlevel, rays 8 are longer than the dorsal ray, the spicules are much longer (395–404 long—i.e., equivalent to 17–24% of worm length), the carene is still present at the level of the ovejector, the female tail is more rounded distally, and the eggs are wider (64–74 by 30–46) (Hasegawa and Syafruddin, 1994).

Discussion

Maxomystrongylus yasumai is apparently shared by murines belonging to several genera, as already shown. However, the high prevalence and high intensity of infection in *M. whiteheadi* suggest that this murine is the primary host of *M. yasumai* in the Kalimantan forest surveyed, although only a limited number of individuals of other murines has been examined. This condition resembles that of *M. musseri* in South Sulawesi, where this nematode is shared by *Maxomys musschenbroekii*, the type host, *Eropeplus canus*, and *Margaretamys elegans*, but the intensity of infection was highest in *M. musschenbroekii* (Hasegawa and Syafruddin, 1994).

The Makassar Strait between Kalimantan and Sulawesi has been known to represent the famous zoogeographical border called Wallace's line, which separates the Oriental and Australian regions. It is therefore suggested that the 2 allied nematodes, *M. yasumai* and *M. musseri*, are derived from a common ancestor and speciated in the geographically isolated conditions. It is of interest that these 2 nematodes seem to have murines of the genus *Maxomys* as their primary hosts in both Kalimantan and Sulawesi. If *Maxomys* was responsible for dispersal of *Maxomystrongylus*, its members in continental Southeast Asia and the Philippines may harbor nematodes of this genus.

Maxomys whiteheadi is distributed widely in continental Southeast Asia and the islands on Sundashelf (Musser and Carleton, 1993). Ow Yang et al. (1983) studied the heligmosomoid fauna of *M. whiteheadi* in the Malay Peninsula and described 4 species in the subfamily Nippostrongylinae. Among them, *H. bulbosus* seems to be closely related to the genus *Maxomystrongylus* because its synlophe has 3 slender left lateral ridges supporting a carene. However, it remains unclear whether *H. bulbosus* actually belongs to *Maxomystrongylus* or not because the unilateral diverticulum of the vagina vera has not been known and the male has been described to have a protruded genital cone (Ow Yang et al., 1983). It is expected that a careful comparison of nematodes of *M. whiteheadi* between the Malay Peninsula and Borneo/Kalimantan will provide a clue to solve the systematic relationship between *Maxomystrongylus* and *Heligmonoides*.

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Announcement

Diagnostic Parasitology Course

The Diagnostic Parasitology course will be offered 4–15 August 1997 at the Uniformed Services University of the Health Sciences, Bethesda, Maryland 20814-4799. This course will consist of a series of lectures and hands-on laboratory sessions covering the diagnosis of parasitic infections of humans. In addition to the examination of specimens, participants will be able to practice various methods used in the diagnosis of intestinal, blood, and tissue parasitic diseases. Parasitic diseases encountered throughout the world will be included. Slide presentations and video tapes will be available for study. The course will be held on the University's campus, utilizing up-to-date lecture rooms and laboratory facilities. Microscopes will be available on a loan basis, and laboratory supplies will be provided. Certain reference specimens will also be available for personal use.

The registration fee for the 2-wk course is $1,000. U.S. Government and Military personnel may take the course at a reduced rate. Those interested should register as soon as possible, as the number of students will be limited. Previous laboratory experience is recommended.

For further information, contact Dr. John H. Cross at (301) 295-3139 or Ms. Ellen Goldman at (301) 295-3129.